Appendix B

Human Health Risk Assessment and Responses to Comments

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LIST OF ACRONYMS

AEGL	Acute Exposure Guidelines
AERMOD	AMS/EPA Regulatory Model
Acute HQ	Acute Hazard Quotient
Acute HI	Acute Hazard Index
AIEC	Acute Inhalation Exposure Criteria
AIHA	American Industrial Hygiene Association
Acute REL	Acute Reference Exposure Level
ATSDR	Agency for Toxic Substances and Disease Registry
CalEPA	California Environmental Protection Agency
CNS	Central Nervous System
CO_2	Carbon Dioxide
CO	Carbon Monoxide
DTI	Dominion Transmission, Inc.
EA	Environmental Assessment
EPA	United States Environmental Protection Agency
ESD	Emergency Shutdown
ERPG	Emergency Response Planning Guidelines
FERC or Commission	Federal Energy Regulatory Commission
GHG	Greenhouse Gas
HAPs	Hazardous Air Pollutants
HHRAP	Human Health Risk Assessment Protocol
HI	Hazard Index
HQ	Hazard Quotient
IRIS	Integrated Risk Information System
lb/day	Pound per day
mg/m^3	Milligram per cubic meter of air
N_2	Nitrogen
NA	Not Available/Applicable
NAAQS	National Ambient Air Quality Standard
NOx	Nitrogen Oxide
NYSDEC	New York State Department of Environmental Conservation
OEHHA	Office of Environmental Health Hazard Assessment
PADEP	Pennsylvania Department of Environmental Protection
PAHs	Polycyclic Aromatic Hydrocarbons
pCi/L	Picocuries per Liter
PM	Particulate Matter
PPRTV	Provisional Peer Reviewed Toxicity Values
RfC	Reference Concentration
RME	Reasonable Maximum Exposure
SO_x	Sulfur Oxide
SUV	Sport Utility Vehicle
TEEL	Temporary Emergency Exposure Limits
TENORM	Technologically Enhanced Naturally Occurring Radioactive Materials
URF	Unit Risk Factor
$\mu g/m^3$	Microgram per cubic meter of air
VOC	Volatile Organic Compound

1.0 INTRODUCTION

The staff of the Federal Energy Regulatory Commission (FERC or Commission) prepared this human health risk assessment as a supplement to the environmental assessment (EA) for the proposed New Market Project by Dominion Transmission, Inc. (DTI). On June 2, 2014, DTI filed an application with the Commission in Docket No. CP14-497-000 for authorization under Section 7(c) of the Natural Gas Act and Part 157 of the Commission's regulations for a Certificate of Public Convenience and Necessity (Certificate) to construct and operate natural gas pipeline aboveground facilities in Chemung, Madison, Montgomery, Tompkins, Herkimer and Schenectady Counties, New York. DTI's proposed project is referred to as the New Market Project (Project).

DTI proposes to construct and operate two new compressor stations in Chemung and Madison Counties; add compression, a new meter and regulator station, and other facilities to one existing compressor station in Montgomery County; add facilities to two existing compressor stations in Tompkins and Herkimer Counties; and modify an existing meter station in Schenectady County. As of September 30, 2015, approximately 1,184 comment letters have been posted to the FERC docket for this Project.

Approximately 12 percent of the comments received on the Project focused on specific emissions and/or air quality and their effect on health. The comments primarily focused on the topics listed below in Table 1. Multiple commenters, including a local health department, provided studies and detailed assessments of potential health issues from compressor station emissions, namely hazardous air pollutants (HAPs[1]) and volatile organic compounds (VOCs), and releases of natural gas contaminants. Commenters also applied studies from production facilities / compressor stations to the proposed transmission compressor station; a comparison we do not believe to be representative. DTI also filed a detailed analysis of potential contaminants. The comments and studies on the docket present widely varying viewpoints on the health risk from the proposed Project. Therefore, FERC staff prepared this human health risk assessment from the emissions for the proposed Sheds, Horseheads and Brookman Corners Compressor Stations to independently analyze human health risks.

This appendix was developed to address the above comments and concerns with the New Market Project, including air modeling and exposure assessments performed by FERC staff and their contractors.

Chapter 2 differentiates the sources of air emissions at the proposed compressor stations, including natural gas emissions and an analysis of transmission gas quality;

Chapter 3 presents the methodology and air emissions modeling cases;

Chapter 4 presents the results of the quantitative human health risk assessment evaluating potential compressor station HAPs emissions from normal full-capacity operations;

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[1] Unless otherwise stated, in this Appendix "HAPs" refers to hazardous air pollutants as defined by the EPA plus other typically recognized air toxics.

Chapter 5 discusses full-station blowdowns and presents the results of a quantitative human health risk assessment evaluation of full station blowdown events;

Chapter 6 discusses air emissions from a regulatory standpoint and puts them in regulatory context and compares them to other rural sources of pollution;

Chapter 7 addresses other comments such as conventional vs. unconventional (i.e., fracked) gas, radon, and effect of potential emissions on food supplies;

Chapter 8 draws conclusions based on the content of this assessment; and

Chapter 9 provides a list of references used in the preparation of this document.

Table 1
Summary of Relevant Comments

Comment	Topics
Specific emissions and resultant air quality impacts from the proposed compressor stations	Volatile organic compounds (VOCs) and specific air toxics such as benzene; toluene; ethylbenzene; xylene; 1,3-butadiene; n-butyl alcohol; carbon disulfide; carbonyl sulfide; chlorobenzene; chloromethane; 1,2-dichloroethane; diethylbenzene; dimethylbenzene; methyl ethyl sulfide; naphthalene; 1,1,1,2-tetrachloroethane; trimethylbenzene; styrene; methane; ethane; butane; and propane
	Carbon monoxide (CO); nitrogen oxides (NO_x); formaldehyde; and ground level ozone
	Greenhouse gases (GHGs)
	Blowdown emissions (odors, radioactivity release, health impacts)
Impact of emissions from specific compressor station locations	Brookman Corners (Montgomery County) (primarily higher emissions than other stations)
	Sheds (Madison County)
Impact of emissions on environment	Unique valley topography
	Impact on food supply (crops, homegrown vegetables, water, fish, game, livestock)
Impact of unconventional gas (“fracked gas”)	
Radiation	
Health Effects due to emissions	Specific and non-specific effects including: cardiovascular, respiratory and neurological damage, birth defects, cancer, leukemia, infertility, burning of lungs, eyes, and throat, muscle aches and pains, mental impairment, severe headaches, and other acute and chronic effects
	Use of tons per year to evaluate health effects

2.0 SOURCES OF AIR EMISSIONS

Section 9 in Part B (B.9) of the EA discusses the potential effect of the Project on local and regional air quality as it relates to the criteria pollutants and the greenhouse gases. This evaluation addresses the potential health effects of toxic air pollutants emitted from the natural gas-fired engines as well as the health effects related to releases of pipeline natural gas from fugitive emissions and venting operations.

Air emissions resulting from the operation of compressor stations includes: exhaust emissions from natural gas combustion in reciprocating internal combustion engines, combustion turbines, and ancillary equipment; and emissions resulting from releases of natural gas from fugitive emissions and from venting.

2.1 Combustion Emissions

Natural gas combustion results in emissions of nitrogen oxide (NO_x), CO, VOCs, particulate matter (PM), sulfur oxide (SO_x), greenhouse gases (primarily carbon dioxide (CO_2)), and hazardous air pollutants (HAPs including formaldehyde). NO_x is formed by various mechanisms. SO_x is formed by oxidation of the trace amounts of sulfur in natural gas, which are typically very low since sulfur is removed during gas processing (EPA, 2000; Branosky et al., 2012; Moore et al., 2014). PM consists primarily of particles in the intake air that are not removed by filters, particles formed by secondary reactions involving SO_x, and condensable gases in the exhaust. CO, VOCs, and HAPs are the products of incomplete combustion (EPA, 2000).

The estimated concentrations of potential HAPs (including VOC HAPs) emissions as a result of Project operations are considered for this analysis. In general, reciprocating internal combustion engines generate more individual HAP pollutants than combustion turbines. The air quality impacts of criteria pollutants are addressed in section B.9.1 of the EA. The potential emissions of air toxics on the extended HAPs list were estimated using operating parameters obtained from compressor engines and turbines, oxidation catalyst specifications and emission factors provided by vendors (for formaldehyde), and the 5th Edition of AP-42 Sections 3.1 and 3.2 for other HAPs (EPA, 2000). Potential emissions were estimated for the maximum load case for each compressor engine or turbine.

The combustion emission sources are as follows:

- Sheds Compressor Station
  - One new natural gas-fired Solar Taurus 70 combustion turbine, rated at 10,880 horsepower
- Horseheads Compressor Station
  - One new natural gas-fired Solar Taurus 70 combustion turbine, rated at 10,880 horsepower
- Brookman Corners Compressor Station
  - One existing natural gas-fired Solar Taurus 60 combustion turbine, rated at 7,410 horsepower
  - One new natural gas-fired Solar Taurus 50 combustion turbine, rated at 6,393 horsepower
  - Two new natural gas-fired Caterpillar G3608 reciprocating internal combustion engines, each rated at 2,370 horsepower

2.2 Natural Gas Releases

We received a number of comments expressing concern regarding the potential health effects from fugitive and blowdown emissions of natural gas itself. Natural gas releases consist of hydrocarbons plus small amounts of nitrogen (N_2) and CO_2. The hydrocarbons are comprised primarily of methane, plus small amounts of ethane, propane, butane, pentane, and hexane. The natural gas composition modeled in this analysis was determined using gas data collected at four different stations over a period of five years by DTI (see chapter 2.3 below for more information). Natural gas would be released as a result of Project-related venting and fugitive emissions.

Vented emissions are defined as those emissions which pass through a stack, vent, or equivalent opening. A compressor may be vented for startup, shutdown, maintenance, or for protection of gas seals from contamination. Individual system components, including the filter/separator, fuel gas meter, and/or fuel filters may be vented for inspection and maintenance. An individual compressor or the entire station may be blown down (i.e., vented) for testing or in the event of an emergency.

Fugitive emissions are defined as those emissions which do not pass through a stack, vent, or other functionally equivalent opening[2], and include natural gas leaks from valves, flanges, pumps, compressors, seals, connections, etc.

Potential fugitive and vented emissions of natural gas were accounted for in the quantitative risk assessment discussed in chapter 4. The gas vented during startup and shutdown of the Sheds and Horseheads Compressor Stations' centrifugal compressors would normally be released to the atmosphere and was therefore included in the evaluation. The gas vented during startup and shutdown of the Brookman Corners Compressor Station's centrifugal compressors would normally be combusted by one of the compressor engines. However, this evaluation conservatively assumed vented gases would still be released to the atmosphere. Natural gas vented to the atmosphere as a result of an emergency shutdown (ESD) event was evaluated separately in chapter 5. The U.S. Department of Transportation regulations require that the ESD system be tested fully on an annual basis. The full station must be blown down to the atmosphere once every five years. In other years, a capped test (a full activation of the ESD system with the blowdown vent capped to prevent release of natural gas to the atmosphere) may be conducted in lieu of a full station blowdown. A full station blowdown may also occur during an emergency condition.

2.3 Natural Gas Quality

Natural gas, comprised primarily of methane, is commonly found in nature mixed with other hydrocarbons and varying amounts of contaminants. Commenters expressed concern over possible contaminants in the transmitted gas, including filing comments linked to health studies and air samples from production areas. While the exact composition of natural gas is chiefly dependent upon the geological source from which it was extracted, all gas must be processed to "pipeline quality" before it is allowed in interstate transmission pipelines (Branosky et al., 2012; Moore et al., 2014). In addition, interstate transmission pipelines interconnect with many other transmission pipeline systems, developing a network that may cross various geological sources. Therefore, the resulting natural gas in most transmission pipelines is well mixed.

[2] 40 CFR 52.21(b)(20)

The term "pipeline quality" is defined in each individual pipeline's tariff[3], and these definitions vary from pipeline to pipeline. Gas quality terms and conditions of the pipeline's tariff ensure the hydrocarbons and contaminants are within acceptable limits for safe and efficient operation of the pipeline. At typical interstate pipeline operating pressures and temperatures, "pipeline quality" natural gas remains in a gaseous state and pipelines, distribution facilities, and end-user equipment are all designed to handle and burn this gas. Individual pipelines may have different standards, practices, and enforcement mechanisms; however, the specifications for gas quality should be based upon sound technical, engineering, and scientific considerations.

DTI provided daily gas quality data for seven sample locations for the past 5 years. Table 2 summarizes the gas quality data for these locations and shows that the natural gas in the transmission pipeline is comprised primarily of methane (~93.3 percent), followed by ethane (~4.7 percent), CO_2, nitrogen, propane and butane (each less than 1 percent) and pentane and hexane (each less than 0.1 percent). These compositions are consistent with "pipeline quality" gas, and the tabulated percentages were used in assessing exposures from both fugitive and vented emissions.

Table 2
Gas Quality Data, Summarized Average Percent by Weight a/

Component	**Borger Station** b/	**Utica Higby Rd** c/	**Brookman Corners Herkimer** d/	**West Schenectady Amsterdam** e/
Carbon Dioxide	0.74	0.75	0.77	0.53
Nitrogen	0.51	0.54	0.55	0.52
Methane	93.47	92.45	93.53	93.86
Ethane	4.58	5.21	4.55	4.60
Propane	0.42	0.77	0.39	0.33
n-Butane	0.13	0.15	0.11	0.08
n-pentane	0.09	0.07	0.05	0.05
n-hexane	0.06	0.06	0.05	0.03
Total	**100**	**100**	**100**	**100**

Notes:
a/ Values rounded to nearest hundredth
b/ Sampling conducted at the Borger Compressor Station in Ithaca, New York, and represents average of four pipelines (L-1, L-30, L-31 and L-550)
c/ Sampling conducted at the M&R Facility at Utica Compressor Station in Utica, New York
d/ Sampling conducted at the M&R Facility at Herkimer Meter Station in Herkimer, New York
e/ Sampling conducted at the M&R Facility at West Schenectady Meter Station in Amsterdam, New York

VOCs in Natural Gas

The commenters cited a number of studies (McKenzie et al., 2012; McKenzie et al., 2014; TCEQ, 2010; Wolf Eagle, 2009; Rabinowitz et al., 2014, Macey et al., 2014) as well as listed VOC and HAPs emissions from compressor stations that potentially impact human health. These compounds included: benzene; toluene; ethylbenzene; xylene; 1,3-butadiene; n-butyl alcohol; carbon disulfide; carbonyl sulfide; chlorobenzene; chloromethane; 1,2-dichloroethane;

3. DTI's Tariff Terms and Conditions for Quality of its natural gas transmission pipelines are publicly available at https://escript.dom.com/jsp/info_post.jsp?&company=dti#

diethylbenzene; dimethylbenzene; methyl ethyl sulfide; naphthalene; 1,1,1,2-tetrachloroethane; trimethylbenzene; styrene; methane; ethane; butane; and propane. While we acknowledge that HAP concentrations may have been documented in communities in close proximity to natural gas production areas, studies documenting these concentrations and emissions from natural gas production areas in general, are not comparable to transmission pipeline compressor stations.

While the term VOCs can refer to highly toxic compounds (such as benzene, toluene, ethylbenzene, xylenes, and others), VOCs are limited to butane, propane, pentane, and hexane in the case of transmission-quality gas in the pipeline. The EPA defines VOCs (40 CFR 51.100(s)) as:

> *Volatile organic compounds (VOC) means any compound of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate, which participates in atmospheric photochemical reactions*.

The definition specifically excludes methane and ethane (among other organic compounds), which have been determined to have negligible photochemical reactivity (40 CFR 51.100(s)(1)). The VOCs category is reported as part of a Title V permit as potential precursors for ozone, a criteria air pollutant. Section B.9.1 of the EA discusses the potential impact of criteria pollutants on ambient regional air quality in the Project area.

3.0 HUMAN HEALTH RISK MODEL FROM NORMAL OPERATIONS

Due to the level of concern regarding potential health effects associated with emissions from the compressor stations, we conducted a quantitative risk assessment to evaluate the potential for short- and long-term health effects due to exposure to HAPs as a result of emissions from natural gas combustion and from the constituents in the pipeline gas released as fugitive emissions.

We conducted a human health risk assessment in accordance with the U.S. Environmental Protection Agency's (EPA's) 2005 Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities (HHRAP; EPA, 2005). The Human Health Risk Assessment Protocol (HHRAP) incorporates risk assessment guidance and methods from the EPA, as well as the experience EPA has gained through conducting and reviewing combustion risk assessments, to provide a comprehensive method of assessing human health risk from combustion emissions. It provides a standardized methodology for conducting combustion risk assessments and, therefore, was chosen as the most appropriate guidance to follow.

To estimate the emission of HAPs, we applied the emission factors from AP-42 (EPA, 2000) to the natural gas-fired engines, emission estimates from fugitive emissions provided by DTI, gas composition data from DTI, and area-specific meteorological data to predict representative concentrations of HAPs for the Brookman Corners, Sheds, and Horseheads Compressor Stations. Specifically, we modeled concentrations from the station property lines. In contrast, concentrations of criteria air pollutants are described in the EA and were modeled from the station fenceline, as the fenceline is used for permitting purposes. We then conducted a human health risk assessment evaluating exposure to the HAPs to determine whether the predicted air concentrations from the potential station emissions would be above a level of health concern within the specific communities.

The human health risk assessment provides modeled estimates of individual risk for the theoretical Resident Reasonable Maximum Exposed (RME) adult and child receptor associated with direct exposures to potential emissions from natural gas combustion, from the constituents in the pipeline gas released as fugitive emissions, and as a result of blowdowns and venting. Potential natural gas combustion by-product emissions and fugitive emissions were evaluated for acute (1-hour) and chronic (long-term) exposure, while potential natural gas emissions as a result of blowdowns and venting were evaluated for acute (1-hour) exposures. These methods used to evaluate exposures and risks, specifically the assumed Resident RME, are consistent with current EPA guidance, and as a conservative measure tend to overestimate potential risks (i.e., be health protective).

3.1 Modeling Compressor Station Emissions

3.1.1 Air Dispersion Model

To assess potential impacts from operation of the Project facilities, we ran the EPA's AMS/EPA Regulatory Model (AERMOD version 14134) for the proposed Horseheads, Sheds, and Brookman Corners Compressor Stations. AERMOD is the EPA-preferred program for short-range (up to 50 kilometers) regulatory air dispersion modeling (EPA, 2014a).

The risk assessment used the same meteorological data sets used to evaluate the criteria pollutants (CO, NO_2, PM_{10}, $PM_{2.5}$, and SO_2), as described in section B.9.1 of the EA. The data sets used for each site were:

- Elmira Airport (2008 – 2012 surface data) and Buffalo Airport (2008 – 2012 upper air data) for the Horseheads Compressor Station.
- Syracuse Airport (2008 – 2012 surface data) and Buffalo Airport (2008 – 2012 upper air data) for the Sheds Compressor Station.
- Rome Airport (2008 – 2012 surface data) and Albany Airport (2008 – 2012 upper air data) for the Brookman Corners Compressor Station.

As noted in section B.9.1 of the EA, the closest surface weather stations were selected as most representative for each Project site. Elmira Airport is 8 miles southwest of the Horseheads Compressor Station site, and Syracuse Airport is 26 miles from the Sheds Compressor Station site. Rome Airport is 40 miles from the Brookman Corners Compressor Station site. Upper air data from Buffalo, New York were used with the Elmira and Syracuse surface data, while Albany upper air data were used with the Rome surface data. The use of these data locations for the New Market Project sites was approved by Ms. Margaret Valis, Chief of the Impact Assessment & Meteorology Section at the New York State Department of Environmental (NYSDEC).

Per risk assessment guidance (EPA, 2005), the starting point for locations of modeled concentrations begins at the facility property line. Concentrations were modeled out to 5 kilometers at regular "receptors" programmed at decreasing resolution with distance. Terrain elevation at each modeled location was obtained using the AERMAP terrain processing program, which includes routines that extract National Elevation Data at 10-meter spacing based on the North American Datum of 1983. The four nearest data points surrounding each receptor point were used to determine receptor point terrain elevations (by interpolation) for air quality model input. The spatial extent and density of receptor points was sufficient to capture the highest predicted concentrations in the study region, which generally occurred near each site's property lines and decreased in magnitude farther downwind.

Since the stack exhaust plumes would be expected to experience building downwash effects, exhaust stack data and the dimensions and orientation of nearby structures were provided by DTI and used as input to the Building Profile Input Program–Prime (BPIP-Prime) program for each of the Sheds, Horseheads, and Brookman Corners Compressor Stations. BPIP-Prime provides the direction-specific downwash parameters used by AERMOD.

3.1.2 Modeling Cases

Normal Operations

We analyzed maximum 1-hour and maximum annual ambient concentrations for the expected emissions from normal, full-capacity, operating conditions. These emissions would primarily be from the combustion of natural gas in the compressor engines and turbines, but would also include fugitive leaks of natural gas and natural gas vented to the atmosphere as a result of startup, shutdown, inspection, maintenance, testing and emergency operations (both described more fully under chapter 2.2 of this appendix). The maximum predicted concentration for each air pollutant was used in the exposure assessment.

Fugitive emission estimates were based on a 2014 report by the EPA's Office of Air Quality Planning and Standards with a 50 percent factor added for conservatism (EPA, 2014b). For potential vented and fugitive emissions, 1-hour and long term (5-year average) ambient concentrations were analyzed for each station (see chapter 4.0 of this appendix for results). Fugitive and vented emissions were modeled as a volume source corresponding in extent to each compressor station's aboveground facilities.

One-hour concentrations were determined by modeling each year of meteorological data separately, from which a 1-hour maximum concentration was determined per receptor point per year. At each receptor point, the five maximum values (based on five separate years) were then averaged together. The receptor point with the highest average was selected for use with the exposure analyses. The long term concentrations were determined by selecting the receptor point with the highest 5-year average concentration.

Blowdown Events

We evaluated full station ESD blowdown events separately from other vented and fugitive emissions. The full station ESD blowdown event was conservatively assumed to occur within a single hour, and the natural gas was assumed to be released though a single 3-meter blowdown stack. This event constitutes the maximum 1-hour release rate for vented natural gas emissions.

The highest 1-hour ambient concentrations from the blowdown events for each compressor station are summarized and discussed in chapter 5, below. The 1-hour concentrations for each compressor station were calculated in the same manner as described above. Note that since blowdowns only contain uncombusted natural gas, the list of air pollutants is much shorter than those shown for combustion.

3.2 Methodology for Estimating Human Health Risk

The 2005 HHRAP Guidance requires that once receptor point locations and potential exposure pathways are identified, the concentrations of emitted chemicals are modeled, and then possible chemical-specific intakes by the identified RME receptors are estimated. This methodology uses theoretically possible exposures, not actual exposures, and is designed to overstate what any individual is likely to experience.

For estimating potential health risk, we assumed the Resident RME receptor (adult and child) would be exposed to these potential maximum compressor station emissions through direct inhalation. For direct inhalation exposures, air concentrations were calculated based on the modeled highest 5-year concentration for long-term exposures or the highest 1-hour concentration (average of maximum 1-hour concentrations from 5 separate years) for short-term exposures at the DTI property line.

The Adult Resident RME receptor was assumed to be an individual exposed to the modeled maximum annual concentration at the property line for 24 hours per day, 350 days per year for 30 years. A Child Resident RME receptor was assumed to be exposed to the same modeled maximum annual concentration for 24 hours per day, 350 days per year for 6 years. These conservative assumptions are in accordance with the 2005 HHRAP Guidance (EPA, 2005).

The equation used to calculate chronic exposure is as follows:

$$EC = \frac{Cchronic \ x \ EF \ x \ ED}{AT \ x \ 365 \ d/yr}$$

Where:

EC	=	Exposure Concentration (c – cancer, nc – non-cancer)
$C_{chronic}$	=	Chronic Air Concentration (ug/m^3, maximum annual concentration)
EF	=	Exposure Frequency (350 d/yr)
ED	=	Exposure Duration – 30 years adult; 6 years child
AT	=	Averaging Time – 70 years cancer intake; ED – non-cancer intake

3.2.1 Chronic Toxicity Values

In accordance with the HHRAP, a hierarchical approach was used to select chronic toxicity criteria for the HAPs evaluated in this human health risk assessment. Cancer and non-cancer toxicity values, in order of preference, were obtained according to the EPA's revised hierarchy of toxicological sources of information (EPA, 2003). The hierarchy was updated to reflect the EPA's use of the best science available on which to base risk assessments. This approach was selected to ensure that the most up-to-date information was used. The recommended toxicity value hierarchy is as follows:

- Tier 1- EPA's Integrated Risk Information System (IRIS) (EPA, 2015a). Toxicity values from IRIS are given first priority. These toxicity values have achieved full intra-agency consensus and have undergone external peer-review. The toxicity values in IRIS represent the EPA's scientific position regarding the toxicity of chemicals based on the data available at the time of the review.
- Tier 2- EPA's Provisional Peer Reviewed Toxicity Values (PPRTVs) – The Office of Research and Development/National Center for Environmental Assessment/Superfund Health Risk Technical Support Center develops PPRTVs on a chemical-specific basis when requested by EPA's Superfund program. Provisional values were obtained from the most recent EPA Regional Screening Level Table (EPA, 2015b).
- Tier 3- Other Toxicity Values – Tier 3 includes additional EPA and non-EPA sources of toxicity information. Priority was given to those sources of information that are the most current, the basis for which is transparent and publicly available, and which have been peer reviewed. Tier 3 values include toxicity values obtained from California EPA (CalEPA), Agency for Toxic Substances and Disease Registry's (ATSDR's) Minimum Risk Levels, and toxicity values obtained from Health Effects Assessment Summary Tables (EPA, 1997). The Tier 3 values were obtained from the most recent Regional Screening Level Table (EPA, 2015b).

The HAPs included in the risk assessment exhibit a combination of potential carcinogenic and/or non-carcinogenic effects. Potential cancer risks were evaluated using inhalation unit risk factors (URFs) expressed in terms of risk per concentration for inhalation exposures (i.e., risk per $\mu g/m^3$ or $(\mu g/m^3)^{-1}$). The URF is the upper-bound excess lifetime cancer risk estimated to result from continuous, lifetime exposure to a constituent at a concentration of 1 $\mu g/m^3$ in air.

Non-carcinogenic effects from exposures were evaluated using inhalation reference concentrations (RfCs) expressed in units of mg/m^3. Reference concentrations have been determined by the EPA and other State or Health Agencies to be an air concentration to which the most sensitive individual can be exposed without a risk for non-cancer health effects. It can be derived from a No Observable Adverse Effect Level, Lowest Observable Adverse Effect Level, or benchmark concentration, with uncertainty factors generally applied to reflect limitations of the data used (e.g., extrapolation of animal exposure to human, use of the Lowest Observable Adverse Effect Level instead of a No Observable Adverse Effect Level, extrapolation of short-term exposure to long-term exposure, sensitive individuals, and strength of the database). Tables 3 and 4 present the URFs and the RfCs used in this evaluation, respectively.

Table 3
Inhalation Unit Risk Values for Cancer Risk

Contaminant	URF ($\mu g/m^3$)$^{-1}$ a/	Weight of Evidence Cancer Guideline Description	Source
Acetaldehyde	2.2E-06	Probable Human Carcinogen	IRIS
Benzene	7.8E-06	Known/Likely Human Carcinogen	IRIS
Benzo(b)fluoranthene	1.1E-04	Probable Human Carcinogen	CalEPA
Butadiene, 1,3-	3.0E-05	Known/Likely Human Carcinogen	IRIS
Carbon Tetrachloride	6.0E-06	Known/Likely Human Carcinogen	IRIS
Chloroform	2.3E-05	Probable Human Carcinogen	IRIS
Chrysene	1.1E-05	Probable Human Carcinogen	CalEPA
Dichloroethane, 1,1-	1.6E-06	NA	CalEPA
Dichloroethane, 1,2-	2.6E-05	Probable Human Carcinogen	IRIS
Dichloropropane, 1,2-	1.0E-05	NA	CalEPA
Dichloropropene, 1,3-	4.0E-06	Known/Likely Human Carcinogen	IRIS
Ethylbenzene	2.5E-06	NA	CalEPA
Ethylene Dibromide	6.0E-04	Likely Human Carcinogen	IRIS
Formaldehyde	1.3E-05	Probable Human Carcinogen	IRIS
Methylene Chloride	1.0E-08	Likely Human Carcinogen	IRIS
Naphthalene	3.4E-05	NA	CalEPA
Propylene Oxide	3.7E-06	Probable Human Carcinogen	IRIS
Tetrachloroethane, 1,1,2,2-	5.8E-05	NA	CalEPA
Trichloroethane, 1,1,2-	1.6E-05	Possible Human Carcinogen	IRIS

a/ = Values provided when available.
Compounds which have no calculated carcinogenic risk were not included in this table.
NA = Not available; CalEPA does not have a weight of evidence classification for cancer.

Table 4
Inhalation Reference Concentrations

Contaminant	RfC mg/m^3 a/	Target Organ/Noncarcinogenic Critical Effects	Source
Acetaldehyde	0.01	Nasal Cavity	IRIS
Acrolein	0.000020	Nasal Cavity	IRIS
Benzene	0.030	Decreased lymphocyte count	IRIS
Biphenyl, 1,1'-	0.00040	Liver and kidneys	PPRTV
Butadiene, 1,3-	0.0020	Reproductive System	IRIS
Carbon Tetrachloride	0.10	Liver	IRIS
Chlorobenzene	0.050	Liver and kidneys	PPRTV
Chloroethane	10	Developmental toxicity	IRIS
Chloroform	0.10	Liver, kidney, Developmental	CalEPA
Dichloroethane, 1,2-	0.0070	CNS	PPRTV
Dichloropropane, 1,2-	0.0040	Nasal Cavity	IRIS
Dichloropropene, 1,3-	0.020	Nasal Cavity	IRIS
Ethylbenzene	1.0	Developmental toxicity	IRIS
Ethylene Dibromide	0.0090	Nasal Cavity	IRIS
Formaldehyde	0.0090	Respiratory System	CalEPA
Hexane, N-	20	Peripheral nervous system	IRIS
Methanol	0.60	Developmental toxicity	IRIS
Methylene Chloride	0.70	Liver	IRIS
Nonane, N-	0.020	Whole Body	PPRTV
Pentane, N-	1.0	No Observable Effect	PPRTV
Naphthalene	0.0030	Nasal Cavity	IRIS
Phenol	0.20	Liver, Cardiovascular, kidney, nervous system	CalEPA
Propylene Oxide	0.030	Nasal Cavity	IRIS
Styrene	1.0	CNS	IRIS
Toluene	0.00020	CNS	IRIS
Trichloroethane, 1,1,2-	0.0050	Nasal Cavity	PPRTV
Trimethylbenzene, 1,2,3-	0.0070	Whole Body	PPRTV
Trimethylbenzene, 1,2,4-	5.0	Blood	PPRTV
Vinyl Chloride	0.10	Liver	IRIS
Xylenes	0.10	CNS	IRIS

Notes:
CNS = Central Nervous System
a/ = Values provided when available.
Compounds which have no chronic inhalation RfCs were not included in this table.

3.2.2 Acute Toxicity Values

Acute values, in order of preference, were obtained as specified in the HHRAP (EPA, 2005):

1. CalEPA Acute Reference Exposure Levels (Acute RELs) - The Acute REL is an exposure that is not likely to cause adverse effects in a human population, including sensitive subgroups, exposed to that concentration for one hour on an intermittent basis (OEHHA, 1999; OEHHA, 2015).
2. EPA Acute Exposure Guidelines (AEGL-1) – The AEGL-1 is the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic nonsensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure. (EPA, 2015c; ORI, 2015)
3. American Industrial Hygiene Association (AIHA) Emergency Response Planning Guidelines – 1 (ERPG-1) - The ERPG-1 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing other than mild transient adverse health effects or perceiving a clearly defined, objectionable odor (AIHA, 2014; ORI, 2015).
4. Temporary Emergency Exposure Limits (TEEL-1) – The TEEL-1 is the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic, nonsensory effects. However, these effects are not disabling and are transient and reversible upon cessation of exposure (NOAA, 2015).

Per the HHRAP recommendation, the CalEPA Acute RELs are used as the first choice when available. For HAPs lacking Acute RELs, acute toxicity values were selected as AEGL-1 values and so on according to the HHRAP hierarchy. The Acute REL and AEGL-1 values are designed to protect a variety of exposure groups including the general public, which includes sensitive subpopulations such as the elderly and children, while the ERPG-1 and TEEL-1 values pertain to nearly all individuals. The acute toxicity values are intended to protect against a variety of toxic endpoints. The Level 1 endpoints used in this hierarchy protect against discomfort or mild health effects and/or objectionable odor. Table 5 presents the acute inhalation exposure criteria (AIEC) used in this evaluation.

Table 5 Acute Inhalation Exposure Criteria		
Contaminant	**AIEC (μg/m^3)**	**Source**
Acenaphthene	3,600	TEEL-1
Acenaphthylene	10,000	TEEL-1
Acetaldehyde	470	CA Acute REL
Acrolein	2.5	CA Acute REL
Benzene	27	CA Acute REL
Benzo(b)fluoranthene	31	TEEL-1
Benzo(g,h,i)perylene	30,000	TEEL-1
Biphenyl, 1,1'-	5,581	TEEL-1
Butadiene, 1,3-	660	CA Acute REL
Butane, N-	13,090,000	AEGL-1
Butyr/Isobutyraldehyde **a**/	42	TEEL-1
Carbon Tetrachloride	1,900	CA Acute REL
Chlorobenzene	46,100	AEGL-1
Chloroethane	264,000	TEEL-1
Chloroform	150	CA Acute REL
Chrysene	600	TEEL-1
Cyclopentane	1,722,000	TEEL-1
Dichloroethane, 1,1-	648,000	TEEL-1
Dichloroethane, 1,2-	202,500	ERPG-1
Dichloropropane, 1,2-	136,200	TEEL-1
Dichloropropene, 1,3-	13,620	TEEL-1
Ethane	79,940,695	TEEL-1 **b**/
Ethylbenzene	143,220	AEGL-1
Ethylene Dibromide	130,730	AEGL-1
Fluoranthene	1,500	TEEL-1
Fluorene	6,600	TEEL-1
Formaldehyde	55	CA Acute REL
Hexane, N-	1,059,000	TEEL-1
Methane	42,642,127	TEEL-1 **b**/
Methanol	28,000	CA Acute REL
Methylcyclohexane	1,608,000	TEEL-1
Methylene Chloride	14,000	CA Acute REL
Methylnaphthalene, 2-	3,000	TEEL-1
Nonane, N-	1,050,000	TEEL-1
Octane, N-	1,401,000	TEEL-1
Pentane, N-	354,000	TEEL-1
Naphthalene	78,600	TEEL-1

Table 5
Acute Inhalation Exposure Criteria

Contaminant	AIEC (µg/m³)	Source
Phenanthrene	760	TEEL-1
Phenol	5,800	CA Acute REL
Propane	9,900,000	AEGL-1
Propylene Oxide	3,100	CA Acute REL
Pyrene	150	TEEL-1
Styrene	21,000	CA Acute REL
Tetrachloroethane, 1,1,2,2-	6,870	TEEL-1
Toluene	37,000	CA Acute REL
Trichloroethane, 1,1,2-	81,900	TEEL-1
Trimethylbenzene, 1,2,3-	688,800	AEGL-1
Trimethylbenzene, 1,2,4-	688,800	AEGL-1
Trimethylbenzene, 1,3,5-	688,800	AEGL-1
Trimethylpentane, 2,2,4-	1,425,487	TEEL-1
Vinyl Chloride	180,000	CA Acute REL
Xylenes	22,000	CA Acute REL

Notes:
a/ = as Butyraldehyde
b/ = Next TEEL update, methane and ethane and TEEL-1 values will be based on the levels to which a simple asphyxiant reduces the oxygen concentration = 65,000 ppm (Freshwater, 2015). Conversion to ug/m³ = 65,000 ppm x MW x 1/24.45 x 1000 ug/mg
AIEC = Acute Inhalation Exposure Criteria
MW = Molecular Weight
TEEL = Temporary Emergency Exposure Limits

4.0 QUANTITATIVE RISK CHARACTERIZATION

The results of the quantitative risk analysis are usually presented in two forms. In the case of human health effects associated with exposure to potential carcinogenic constituents, risk estimates are expressed as the lifetime probability of additional cancer risk associated with the given RME exposure. The inhalation cancer risks are calculated as:

$$\text{Cancer Risk} = EC\ \left(\frac{\mu g}{m^3}\right) x\ URF\ \frac{1}{\mu g/m^3}$$

The individual cancer risks are then summed across chemicals to calculate a total excess lifetime cancer risk for each RME receptor. In numerical terms, the excess lifetime cancer risks are presented in both decimal and scientific notation in this report. Thus, an estimated excess lifetime cancer risk of 0.0001 or 1E-4 means an incremental lifetime cancer risk of 1 in 10,000; 0.00001 or 1E-5 means an incremental lifetime risk of 1 in 100,000 and so on. In order to evaluate potential carcinogenic health effects, the EPA has established benchmarks within which they strive to manage risk. To evaluate potential carcinogenic risks, the EPA generally uses a risk range of 0.0001 (1 in 10,000) to 0.000001 (1 in 1,000,000) (EPA, 1990). The risk level of 1 in 10,000 indicates a 1 in 10,000 chance of developing cancer due to lifetime exposure to a substance. Lifetime exposure to a substance with a cancer risk of 1 in 10,000 would increase one's current chance of cancer from all causes (which is currently a 0.5 (1 in 2) chance for males and a 0.33 (1 in 3) chance for females (American Cancer Society, 2014)) by 0.0001.

For determining whether non-cancer health effects may be a concern, the chronic hazard quotient (HQ) is used. The HQ for inhalation exposures is calculated as:

$$\mathrm{HQ} = \frac{EC\left(\frac{\mu g}{m^3}\right) x\ 0.001\ \frac{mg}{\mu g}}{RfC\ (\frac{mg}{m^3})}$$

The HQs are then summed across individual chemicals to calculate a hazard index (HI) for each RME receptor. The HQs represent a ratio and are presented in both decimal and scientific notation in this report. Therefore, a HQ of 0.25 means, for example, that the estimated exposure dose is 25 percent of the RfC. A HQ of 2.5E-5 means that the exposure dose is 0.0025 percent of the RfC.

In evaluating acute effects, the Acute Hazard Quotient (Acute HQ) for inhalation exposures to potential emissions from normal operations is calculated as:

$$\text{Acute HQ} = \frac{1{-}hr\ \max air\ concentration\left(\frac{\mu g}{m^3}\right)}{AIEC\ (\frac{\mu g}{m^3})}$$

In evaluating acute effects, the Acute HQ for inhalation exposures to potential emissions from the ESD blowdown event scenario is calculated as:

$$\text{Acute HQ} = \frac{1{-}hr\ \max air\ concentration\left(\frac{mg}{m^3}\right)}{AIEC\ (\frac{mg}{m^3})}$$

The Acute HQs are then summed across individual chemicals to calculate an Acute Hazard Index (Acute HI) for each receptor.

In order to evaluate the potential for acute and chronic non-cancer health effects, the EPA generally uses a benchmark hazard index/quotient of 1.0. Acute and chronic non-cancer HIs for each receptor were obtained by adding all HAP-specific HQs regardless of target organ potentially affected or type of health effect. HIs were then compared to the EPA non-cancer benchmark of 1.0. Because RfCs incorporate uncertainty factors designed to provide a margin of safety, a HI above 1 does not necessarily suggest a likelihood of adverse effects and only indicates that a potential may exist for adverse health effects. A non-cancer HI less than 1, however, suggests that exposures are likely to be without an appreciable risk of non-cancer effects during a lifetime. In other words, a hazard index below 1.0 is considered "safe" with a margin of error. It is important to emphasize that the level of concern does not increase linearly as the non-cancer HI value increases (EPA, 1989).

4.1 Horseheads Compressor Station, Normal Full-Capacity Operations

Table 6 provides a summary of the results from chronic exposure to the potential emissions from the Horseheads Compressor Station and shows that the emissions would be below a level of health concern. The cancer risks for the adult and child Resident RME receptors would be 0.00000001 (1 in 100,000,000) and 0.000000002 (2 in 1,000,000,000), respectively, which are well below the EPA's acceptable risk range of 0.000001 to 0.0001 (1 in 10,000 to 1 in 1,000,000). The non-cancer HI for both the adult and child Resident RME receptors would be 0.0024 which is well below the benchmark HI of 1.0.

Table 6
Chronic Risk Assessment Results
Proposed Horseheads Compressor Station

Pollutant	Modeled Air Concentration ($\mu g/m^3$) a/	URF $(\mu g/m^3)^{-1}$	Adult Cancer Risk	Child Cancer Risk	RfC (mg/m^3)	Adult & Child HQ
Acetaldehyde	0.00024	2.2E-06	2.2E-10	4.4E-11	0.0090	2.6E-05
Acrolein	3.9E-05	NA	NA	NA	0.000020	0.0019
Benzene	7.2E-05	7.8E-06	2.3E-10	4.6E-11	0.030	2.3E-06
Butadiene, 1,3-	2.6E-06	3.0E-05	3.2E-11	6.4E-12	0.0020	1.2E-06
Ethylbenzene	0.00019	2.5E-06	2.0E-10	4.0E-11	1.0	1.9E-07
Formaldehyde	0.0017	1.3E-05	9.0E-09	1.8E-09	0.0090	0.00018
Hexane, N-	0.095	NA	NA	NA	0.70	0.00013
Naphthalene	7.8E-06	3.4E-05	1.1E-10	2.2E-11	0.0030	2.5E-06
Pentane, N-	0.16	NA	NA	NA	1.0	0.00015
Propylene Oxide	0.00018	3.7E-06	2.7E-10	5.3E-11	0.030	5.6E-06
Toluene	0.00078	NA	NA	NA	5.0	1.5E-07
Xylenes	0.00039	NA	NA	NA	0.10	3.7E-06
Total			**1E-08**	**2E-09**		**0.0024**
Benchmark Level			**0.000001**	**0.000001**		**1.0**

Notes:
a/ Highest predicted 5-year average concentration at or beyond the property line
URF = Unit Risk Factor
RfC = Reference Concentration
HQ = Hazard Quotient
NA = Not applicable. These compounds do not contribute to calculated cancer risk.

Table 7 presents a summary of the results from acute exposure to the highest predicted 1-hour emissions from the Horseheads Compressor Station and shows that the potential emissions would be below a level of health concern. The total Acute HI would be 0.0062 which is well below the benchmark Acute HI of 1.0.

Table 7 Acute Risk Assessment Results Proposed Horseheads Compressor Station			
Pollutant	**Modeled Air Concentration ($\mu g/m^3$) a/**	**AIEC ($\mu g/m^3$)**	**Acute HQ b/**
Acetaldehyde	0.029	470	6.2E-05
Acrolein	0.0047	3	0.0019
Benzene	0.0087	27	0.00032
Butadiene, 1,3-	0.00031	660	4.7E-07
Butane	12	13,090,000	9.0E-07
Ethane	434	79,940,695	5.4E-06
Ethylbenzene	0.023	143,220	1.6E-07
Formaldehyde	0.20	55	0.0037
Hexane, N-	5.4	1,059,000	5.1E-06
Methane	7,830	42,642,127	0.00018
Naphthalene	0.00095	78,600	1.2E-08
Pentane, N-	9.1	354,000	2.6E-05
Propane	64	9,900,000	6.5E-06
Propylene Oxide	0.021	3,100	6.8E-06
Toluene	0.095	37,000	2.6E-06
Xylenes	0.047	22,000	2.1E-06
Total Acute HI			**0.0062**
Benchmark Level			**1.0**

Notes:
a/ Highest predicted 1-hour concentrations at or beyond the property line
b/ Acute HQ = Acute Hazard Quotient (Air Concentration/AIEC)
AIEC = Acute Inhalation Exposure Criteria
Acute HI = Acute Hazard Index

4.2 Sheds Compressor Station, Normal Full-Capacity Operations

Table 8 presents a summary of the results from chronic exposure to the potential emissions from the Sheds Compressor Station and shows that the emissions would be below a level of health concern. The cancer risk for the adult and child Resident RME receptor would be 0.00000002 (2 in 100,000,000) and 0.000000003 (3 in 1,000,000,000), respectively, which are well below the EPA's acceptable risk range of 0.000001 to 0.0001 (1 in 10,000 to 1 in 1,000,000). The non-cancer HI for the adult and child Resident RME receptor would be 0.0037, which is well below the benchmark HI of 1.0.

Table 8
Chronic Risk Assessment Results
Proposed Sheds Compressor Station

Pollutant	Modeled Air Concentration (μg/m³) a/	URF (μg/m³)⁻¹	Adult Cancer Risk	Child Cancer Risk	RfC (mg/m³)	Adult & Child HQ
Acetaldehyde	0.00040	2.2E-06	3.7E-10	7.3E-11	0.0090	4.3E-05
Acrolein	6.5E-05	NA	NA	NA	0.000020	0.0031
Benzene	0.00012	7.8E-06	3.9E-10	7.8E-11	0.030	3.9E-06
Butadiene, 1,3-	4.4E-06	3.0E-05	5.4E-11	1.1E-11	0.0020	2.1E-06
Ethylbenzene	0.00032	2.5E-06	3.3E-10	6.7E-11	1.0	3.1E-07
Formaldehyde	0.0029	1.3E-05	1.5E-08	3.1E-09	0.0090	0.00031
Hexane, N-	0.089	NA	NA	NA	0.70	0.00012
Naphthalene	1.3E-05	3.4E-05	1.8E-10	3.7E-11	0.0030	4.2E-06
Pentane, N-	0.15	NA	NA	NA	1.0	0.00015
Propylene Oxide	0.00029	3.7E-06	4.5E-10	8.9E-11	0.030	9.4E-06
Toluene	0.0013	NA	NA	NA	5.0	2.5E-07
Xylenes	0.00065	NA	NA	NA	0.10	6.2E-06
Total			**2E-08**	**3E-09**		**0.0037**
Benchmark Levels			**0.000001**	**0.000001**		**1.0**

Notes:
a/ Highest predicted 5-year average concentration at or beyond the property line
URF = Unit Risk Factor
RfC = Reference Concentration
HQ = Hazard Quotient
NA = Not applicable. These compounds do not contribute to calculated cancer risk.

Table 9 presents a summary of the results from acute exposure to the highest predicted 1-hr emissions from the Sheds Compressor Station and shows that the potential emissions would be below a level of health concern. The total Acute HI would be 0.0072, which is well below the benchmark Acute HI of 1.0.

Table 9 Acute Risk Assessment Results Proposed Sheds Compressor Station			
Pollutant	**Modeled Air Concentration ($\mu g/m^3$) a/**	**AIEC ($\mu g/m^3$)**	**Acute HQ b/**
Acetaldehyde	0.03	470	7.2E-05
Acrolein	0.01	2.5	0.0022
Benzene	0.00	660	5.5E-07
Butadiene, 1,3-	0.01	27	0.00038
Butane	7.74	13,090,000	5.9E-07
Ethane	284	79,940,695	3.6E-06
Ethylbenzene	0.03	143,220	1.9E-07
Formaldehyde	0.24	55	0.0044
Hexane, N-	3.52	1,059,000	3.3E-06
Methane	5,120	42,642,127	0.00012
Naphthalene	0.00	78,600	1.4E-08
Pentane, N-	5.98	354,000	1.7E-05
Propane	42.03	9,900,000	4.2E-06
Propylene Oxide	0.02	3,100	7.9E-06
Toluene	0.11	37,000	3.0E-06
Xylenes	0.05	22,000	2.5E-06
Total Acute HI			**0.0072**
Benchmark Level			**1.0**

Notes:
a/ Highest predicted 1-hour concentrations at or beyond the property line
b/ Acute HQ = Acute Hazard Quotient (Air Concentration/AIEC)
AIEC = Acute Inhalation Exposure Criteria
Acute HI = Acute Hazard Index

4.3 Brookman Corners Compressor Station, Normal Full-Capacity Operations

Table 10 presents a summary of the results from chronic exposure to the potential emissions from the Brookman Corners Compressor Station and shows that the emissions would be below a level of health concern. The cancer risk for the adult and child Resident RME receptors would be 0.000001 (1 in 1,000,000) and 0.0000002 (2 in 10,000,000), respectively, which are at or below the lowest risk level of EPA's acceptable risk range of 0.0000001 to 0.0001 (1 in 10,000 to 1 in 1,000,000). The non-cancer HI for the adult and child Resident RME receptor would be 0.97, which is below the benchmark HI of 1.0. Commenters specifically expressed concern over the concentrations of formaldehyde that would be emitted from the Brookman Corners Compressor Station. As shown in table 10, the resultant cancer risks for the adult and child Resident RME receptors would be 0.0000006 (6 in 10,000,000) and 0.0000001 (1 in 10,000,000), which are below the EPA's acceptable risk range of 0.000001 to 0.0001 (1 in 10,000 to 1 in 1,000,000). Formaldehyde's non-cancer HQ for the adult and child Resident RME receptor would be 0.013, which is well below the benchmark HI of 1.0.

Table 10 Chronic Risk Assessment Results Proposed Modified Brookman Corners Compressor Station						
Pollutant	**Modeled Air Concentration ($\mu g/m^3$) a/**	**URF ($\mu g/m^3$)$^{-1}$**	**Adult Cancer Risk**	**Child Cancer Risk**	**RfC (mg/m^3)**	**Adult & Child HQ**
Acetaldehyde	0.13	2.2E-06	1.1E-07	2.3E-08	0.0090	0.013
Acrolein	0.019	NA	NA	NA	0.000020	0.93
Benzene	0.0067	7.8E-06	2.1E-08	4.3E-09	0.030	0.00021
Benzo(b)fluoranthene	2.5E-06	1.1E-04	1.1E-10	2.3E-11	NA	NA
Biphenyl, 1,1'-	0.0032	NA	NA	NA	0.00040	0.0076
Butadiene, 1,3-	0.0040	3.0E-05	5.0E-08	9.9E-09	0.0020	0.0019
Carbon Tetrachloride	0.00055	6.0E-06	1.4E-09	2.7E-10	0.10	5.3E-06
Chlorobenzene	0.00046	NA	NA	NA	0.050	8.8E-06
Chloroethane	3.0E-05	NA	NA	NA	10.0	2.9E-09
Chloroform	0.00043	2.3E-05	4.1E-09	8.1E-10	0.0980	4.2E-06
Chrysene	1.0E-05	1.1E-05	4.5E-11	9.0E-12	NA	NA
Dichloroethane, 1,1-	0.00036	1.6E-06	2.4E-10	4.7E-11	NA	NA
Dichloroethane, 1,2-	0.00036	2.6E-05	3.8E-09	7.7E-10	0.0070	4.9E-05
Dichloropropane, 1,2-	0.00040	1.0E-05	1.6E-09	3.3E-10	0.0040	9.6E-05
Dichloropropene, 1,3-	0.00040	4.0E-06	6.6E-10	1.3E-10	0.020	1.9E-05
Ethylbenzene	0.00071	2.5E-06	7.3E-10	1.5E-10	1.0	6.8E-07
Ethylene Dibromide	0.00067	6.0E-04	1.7E-07	3.3E-08	0.0090	7.1E-05
Formaldehyde	0.12	1.3E-05	6.4E-07	1.3E-07	0.0090	0.013
Hexane, N-	0.21	NA	NA	NA	0.70	0.00029
Methanol	0.038	NA	NA	NA	20.0	1.8E-06
Methylene Chloride	0.00030	1.0E-08	1.2E-12	2.5E-13	0.60	4.8E-07
Naphthalene	0.0011	3.4E-05	1.6E-08	3.1E-09	0.0030	0.00036
Nonane, N-	0.0017	NA	NA	NA	0.020	7.9E-05
Pentane, N-	0.37	NA	NA	NA	1.0	0.00035
Phenol	0.00036	NA	NA	NA	0.20	1.7E-06
Propylene Oxide	0.00024	3.7E-06	3.6E-10	7.3E-11	0.030	7.7E-06
Styrene	0.00036	NA	NA	NA	1.0	3.5E-07
Toluene	0.0066	NA	NA	NA	5.0	1.3E-06
Tetrachloroethane, 1,1,2,2-	0.00060	5.8E-05	1.4E-08	2.9E-09	NA	NA
Trichloroethane, 1,1,2-	0.00048	1.6E-05	3.2E-09	6.3E-10	0.00020	0.0023
Trimethylbenzene, 1,2,3-	0.00035	NA	NA	NA	0.0050	6.7E-05
Trimethylbenzene, 1,2,4-	0.00022	NA	NA	NA	0.0070	3.0E-05
Vinyl Chloride	0.00022	4.4E-06	4.0E-10	8.0E-11	0.10	2.1E-06
Xylenes	0.0030	NA	NA	NA	0.10	2.9E-05
Total			**0.000001**	**0.0000002**		**0.97**
Benchmark Levels			**0.000001**	**0.000001**		**1.0**

Notes:
a/ Highest predicted 5-year average concentration at or beyond the property line
URF = Unit Risk Factor
RfC = Reference Concentration
HQ = Hazard Quotient
NA = Not applicable. These compounds do not contribute to calculated cancer risk.

Table 11 presents a summary of the results from acute exposure to highest predicted 1-hour emissions from the Brookman Corners Compressor Station and shows that the potential emissions would be below a level of health concern. The total Acute HI would be 0.26, which is below the benchmark Acute HI of 1.0.

Table 11
Acute Risk Assessment Results
Proposed Modified Brookman Corners Compressor Station

Pollutant	Modeled Air Concentration ($\mu g/m^3$) a/	AIEC ($\mu g/m^3$)	Acute HQ b/
Acenaphthene	0.00046	3,600	1.3E-07
Acenaphthylene	0.0020	10,000	2.0E-07
Acetaldehyde	3.1	470	0.0066
Acrolein	0.48	2.5	0.19
Benzene	0.16	27	0.0060
Benzo(b)fluoranthene	6.0E-05	31	1.9E-06
Benzo(g,h,i)perylene	0.00015	NA	NA
Biphenyl, 1,1'-	0.00015	30,000	5.0E-09
Butadiene, 1,3-	0.078	5,581	1.4E-05
Butane, N-	0.10	660	0.00015
Butyr/Isobutyraldehyde c/	16	13,090,000	1.2E-06
Carbon Tetrachloride	0.037	42	0.00089
Chlorobenzene	0.014	1,900	7.1E-06
Chloroethane	0.011	46,100	2.4E-07
Chloroform	0.00069	264,000	2.6E-09
Chrysene	0.011	150	7.0E-05
Cyclopentane	0.00026	600	4.3E-07
Dichloroethane, 1,1-	0.084	1,722,000	4.9E-08
Dichloroethane, 1,2-	0.0087	648,000	1.3E-08
Dichloropropane, 1,2-	0.0087	202,500	4.3E-08
Dichloropropene, 1,3-	0.010	136,200	7.3E-08
Ethane	0.010	13,620	7.2E-07
Ethylbenzene	597	79,940,695	7.5E-06
Ethylene Dibromide	0.015	143,220	1.1E-07
Fluoranthene	0.016	130,730	1.3E-07
Fluorene	0.00041	1,500	2.7E-07
Formaldehyde	0.0021	6,600	3.2E-07
Hexane, N-	2.8	55	0.051
Methane	7.4	1,059,000	7.0E-06
Methanol	10764	42,642,127	0.00025
Methylcyclohexane	0.92	28,000	3.3E-05
Methylene Chloride	0.45	1,608,000	2.8E-07
Methylnaphthalene, 2-	0.0074	14,000	5.3E-07
Naphthalene	0.012	3,000	4.1E-06

Table 11
Acute Risk Assessment Results
Proposed Modified Brookman Corners Compressor Station

Pollutant	Modeled Air Concentration (μg/m^3) a/	AIEC (μg/m^3)	Acute HQ b/
Nonane, N-	0.028	78,600	3.5E-07
Octane, N-	0.041	1,050,000	3.9E-08
Pentane, N-	0.13	1,401,000	9.3E-08
Phenanthrene	13	354,000	3.6E-05
Phenol	0.0039	760	5.1E-06
Propane	0.0089	5,800	1.5E-06
Propylene Oxide	88	9,900,000	8.9E-06
Pyrene	0.0094	3,100	3.0E-06
Styrene	0.00050	150	3.3E-06
Tetrachloroethane, 1,1,2,2-	0.0087	21,000	4.2E-07
Toluene	0.015	6,870	2.2E-06
Trichloroethane, 1,1,2-	0.15	37,000	4.1E-06
Trimethylbenzene, 1,2,3-	0.012	81,900	1.4E-07
Trimethylbenzene, 1,2,4-	0.0085	688,800	1.2E-08
Trimethylbenzene, 1,3,5-	0.0053	688,800	7.7E-09
Trimethylpentane, 2,2,4-	0.013	688,800	1.8E-08
Vinyl Chloride	0.092	1,425,487	6.5E-08
Xylenes	0.0055	180,000	3.1E-08
Total Acute HI			**0.26**
Benchmark Level			**1.0**

Notes:
a/ Highest predicted 1-hour concentrations at or beyond the property line
b/ Acute HQ = Acute Hazard Quotient (Air Concentration/AIEC)
c/ as Butyraldehyde
AIEC = Acute Inhalation Exposure Criteria
Acute HI = Acute Hazard Index

5.0 SHORT-TERM EXPOSURES FROM ESD BLOWDOWNS

DTI provided information regarding quantities of natural gas released as a result of venting and blowdown events from the proposed compressor stations. The quantities and types of events are summarized in table 12.

To prevent a loss of valuable product, transmission pipeline system operators implement methods to minimize the frequency of and amount of air emissions from unit and compressor station venting and blowdowns, limiting venting to when necessary for maintenance or testing. ESD tests are typically capped (the blowdown vent is capped to prevent release of natural gas to the atmosphere) to minimize gas loss except for the required full test every 5 years. The venting of centrifugal compressors for shutdowns greater than 1 hour is necessary to protect the equipment. Since Brookman Corners would have reciprocating engines normally in operation, DTI states that these units would be utilized to combust vented gas from the centrifugal compressors.

Table 12
Quantity of Gas Vented During Routine Operations

Station	Start-up a/ lb/event	Shut-down b/ lb/event	ESD Blowdown lb/event	Total d/ lb/year
Horseheads	1,690	3,379	22,232	88,928
Sheds	1,423	2,801	31,125	88,928
Brookman Corners	NA c/	NA c/	26,679	88,928

Note:
NA = Not Applicable
a/ Gas is purged prior to start-up of centrifugal compressors.
b/ Gas is purged from a centrifugal compressor after shutdowns lasting more than 1 hour.
c/ DTI stated that the gas vented during startup and shutdown of the centrifugal compressors (both existing and new units) would normally be vented to the new reciprocating engines and combusted. At least one reciprocating engine would normally be running, so it would be rare that any centrifugal compressor startup or shutdown gas would need to be vented at Brookman Corners.
d/ Totals not expected to be exceeded. Includes non-emergency and emergency gas venting, but not start-up and shut-down releases. Non-emergency venting includes venting of compressor(s) for maintenance and/or protection of gas seals from contamination. Individual system components can be vented for inspection and maintenance, including the filter/separator, fuel gas meter, and/or fuel filters. The annual quantity of gas vented depends on the frequency of maintenance needed.

To evaluate potential exposure to HAPs from blowdown emissions, we evaluated the venting of natural gas during a full station blowdown for ESD system testing, which would occur every five years. This scenario is also intended to be representative of a full station emergency blowdown event and represents a worst-case scenario. The highest predicted 1-hour concentrations at or beyond the property line were modeled assuming the full-station ESD system testing can potentially occur during any time of the day and that all vented gas is emitted in 1-hour. Note the modeling results are very conservative since full station blowdowns are a rare event assumed to occur at any hour of the modeled year (including evenings, which have meteorological unfavorable conditions for air dispersion such as calmer winds and a stable atmosphere). The resulting air concentrations were evaluated using the acute toxicity criteria discussed in chapter 3.2.2 and the results are presented in tables 13 through 15 for Horseheads, Sheds, and Brookman Corners, respectively.

In addition to the acute health risk assessment, we also analyzed whether trace components of released natural gas would be detectable by comparing modeled concentrations to odor detection thresholds. An odor detection threshold is the lowest concentration of odor compound in air at which 50 percent of the tested population are aware of an added substance to clean air, but not necessarily recognized as an actual odor. The detectible odor threshold of propane is 36,000 mg/m^3 (Patty, 1963). A range of odor threshold values were found in the literature: pentane ranges from 4.13 mg/m^3 (Nagata, 2015) to 2950 mg/m^3 (AIHA, 1966)), and hexane ranges from 5.3 mg/m^3 (Nagata, 2015) to 459 mg/m^3 (Amoore and Hautala, 1983). We used the lowest published values for analysis and discussion.

There would be a potential for nearby residents to perceive a gasoline-like odor during the ESD event. Methane and ethane are considered odorless compounds. Propane is described as having a faint petroleum-like odor at high concentrations. The typical “rotten egg” odor many people associate with natural gas comes not from the hydrocarbon constituents of the natural gas itself, but of odorization compounds (typically, mercaptans) added to natural gas distribution systems. DTI does not propose to odorize the natural gas on its transmission system.

5.1 Horseheads Compressor Station

Table 13 provides the results of the acute evaluation of an ESD blowdown event. The total Acute HI of 0.87, is less than the benchmark of 1.0 and therefore would be below a level of potential concern. The predicted propane air concentration is 247 mg/m^3, which is well below the detectible odor threshold. The modeled air concentrations for pentane and hexane are approximately 9-fold and 4-fold higher, respectively, than the lowest obtained odor threshold values. It should be noted however, that these modeled concentrations began at the property line and assuming that the full volume of gas would be released within an hour. In actuality, factors such as venting the gas over a longer period of time and increased distance from the property line would decrease the concentration of gas and also decrease the potential for an odor event. Based upon the current modeling, at a distance of 200 feet beyond the property line, concentrations would decrease by approximately 60 percent. The closest residence to the point of the modeled maximum pentane and hexane concentrations is 1,125 feet; therefore, it is less likely that an odor would be detected at the nearest residence.

Table 13
Acute Risk Assessment Results
Proposed Horseheads Compressor Station
5 year ESD Blowdown Event

Pollutant	Modeled Air Concentration (mg/m^3) a/	AIEC (mg/m^3)	Acute HQ b/
Methane	30,064	42,642	0.71
Ethane	1,667	79,941	0.021
Propane	247	9,900	0.025
Butane, N-	45	13,090	0.0035
Pentane, N-	35	354	0.099
Hexane, N-	21	1,059	0.020
Total Acute HI			**0.87**
Benchmark Level			**1.0**

Notes:
a/ Highest predicted 1-hour concentrations at the property line
b/ Acute HQ = Acute Hazard Quotient (Air Concentration/AIEC)
AIEC = Acute Inhalation Exposure Criteria
Acute HI = Acute Hazard Index

5.2 Sheds Compressor Station

Table 14 provides the results of the acute evaluation of an ESD blowdown event. The total Acute HI of 0.57, is less than the benchmark of 1.0 and would be below a level of potential concern.

Table 14 Acute Risk Assessment Results Proposed Sheds Compressor Station 5 year ESD Blowdown Event			
Pollutant	**Modeled Air Concentration (mg/m^3) a/**	**AIEC (mg/m^3)**	**Acute HQ b/**
Methane	19,565	42,642	0.46
Ethane	1,085	79,941	0.014
Propane	161	9,900	0.016
Butane, N-	30	13,090	0.0023
Pentane, N-	23	354	0.065
Hexane, N-	13	1,059	0.013
Total Acute HI			**0.57**
Benchmark Level			**1.0**

Notes:
a/ Highest predicted 1-hour concentrations at the property line
b/ Acute HQ = Acute Hazard Quotient (Air Concentration/AIEC)
AIEC = Acute Inhalation Exposure Criteria
Acute HI = Acute Hazard Index

The modeled propane air concentration (161 mg/m^3) is well below the detectible odor threshold. However, there would be a potential for nearby residents to perceive a gasoline-like odor during the ESD event from pentane and hexane. The modeled air concentrations for pentane and hexane are approximately 6-fold and 2-fold higher, respectively, than the lowest obtained odor threshold values. It should be noted however, that these concentrations were modeled beginning at the property line and were modeled such that the full volume of gas is released within an hour. In actuality, factors such as venting the gas over a longer period of time and increased distance from the property line will decrease the concentration of gas and also decrease the potential for an odor event. Based upon the current modeling, at a distance of 200 feet beyond the property line, concentrations would decrease by approximately 50 percent. The closest residence to the point of the modeled maximum pentane and hexane concentrations is 1,375 feet; therefore, it is less likely that an odor would be detected at the nearest residence.

5.3 Brookman Corners Compressor Station

Table 15 provides the results of the acute evaluation of an ESD blowdown event for Brookman Corners. The total Acute HI of 0.20 is less than the benchmark of 1.0 and, therefore, would be below a level of concern for potential health effects.

The modeled propane and hexane air concentrations are below the detectible odor thresholds. Although the modeled concentration of pentane is approximately twice the lower odor threshold, there would be a low potential for nearby residents to be able to perceive its gasoline-like odor. These concentrations were modeled at the property line and were modeled such that the full volume of gas is released within an hour. In actuality, factors such as venting the gas over a longer period of time and increased distance from the property line would decrease the concentration of gas and also decrease the potential for an odor event. Based upon the current modeling, at a distance of 200 feet beyond the property line, concentrations would decrease by approximately 20 percent. The closest residence to the point of the modeled maximum hexane concentration is 1,050 feet; therefore, it is less likely that an odor would be detected at the nearest residence.

Table 15
Acute Risk Assessment Results
Proposed Modified Brookman Corners Compressor Station
5 year ESD Blowdown Event

Pollutant	Modeled Air Concentration (mg/m^3) a/	AIEC (mg/m^3)	Acute HQ b/
Methane	6,800	42,642	0.16
Ethane	377	79,941	0.0047
Propane	56	9,900	0.0056
Butane, N-	10	13,090	0.00079
Pentane, N-	7.9	354	0.022
Hexane, N-	4.7	1,059	0.0044
Total Acute HI			**0.20**
Benchmark Level			**1.0**

Notes:
a/ Highest predicted 1-hour concentrations at the property line
b/ Acute HQ = Acute Hazard Quotient (Air Concentration/AIEC)
AIEC = Acute Inhalation Exposure Criteria
Acute HI = Acute Hazard Index

6.0 AIR EMISSIONS IN CONTEXT

The potential emissions, as a result of the Project improvements, include the criteria pollutants (CO, NO_x, ozone, CO, SO_x, and PM), greenhouse gases (GHGs) (primarily CO_2 and methane), and HAPs (which includes those HAPs as defined by the EPA plus other typically recognized air toxics). The criteria pollutants and greenhouse gases are both heavily regulated by EPA under the Clean Air Act. The criteria pollutants are regulated through the National Ambient Air Quality Standards (NAAQS) and the GHGs are covered by the Prevention of Significant Deterioration and Title V Operating Permit programs. Specific HAPs are regulated under the Clean Air Act (Section 112b). EPA regulates HAPS using emission control standards; however, there are no NAAQS for these types of pollutants. Therefore, these compounds are compared to health-protective toxicity values, screening air concentrations, and reference concentrations rather than air quality standards (EPA, 2015e).

The screening modeling air impact analysis conducted for Project improvements as discussed in section B.9.1 of the EA, indicates that concentrations of criteria pollutants due to operation of the stations would remain below applicable NAAQS standards when combined with background concentrations obtained from the nearest monitoring stations. Additionally, emissions of GHGs from the Project would not have a direct impact on the environment in the Project area.

We considered the impacts of potential HAP emissions on human health for the risk assessment presented in this Appendix. Acute and chronic exposure to HAPs from natural gas combustion were evaluated using health protective toxicity values and exposure assumptions and were determined to be below a level of health concern. These HAPs are generally products of incomplete combustion and, therefore, are commonly present in ambient air. The modeled concentrations for all three compressor stations would be below what has been typically measured in ambient air. For example, the polycyclic aromatic hydrocarbon (PAH) compounds (acenaphthene, acenaphthylene, benzo(b)fluoranthene, benzo(g,h,i)perylene, chrysene, fluorene, fluoranthene, naphthalene, 2-methylnaphthalene, phenanthrene and pyrene), are present in the environment as a result of natural activities (forest fires and volcanoes) and man-made activities, the largest single source being the burning of wood in homes. Automobile and truck emissions are also a major source of polycyclic aromatic hydrocarbons (PAHs) in ambient air (ATSDR, 1995). Measured rural air concentrations of PAHs range from 0.00001 to 0.00012 µg/m^3 in summer and 0.00008 to 0.00132 µg/m^3 in winter (ATSDR, 1995). The highest concentrations of PAHs were modeled for the Brookman Corners Station and range in concentration from 0.000002 to 0.0012 µg/m^3 which are within the range of background.

The highest modeled concentration of formaldehyde among the three compressor stations was at Brookman Corners. The modeled concentration at the property line is approximately 0.12 µg/m^3, which is 100 to 300-times less than the typical ambient formaldehyde levels of 12 to 37 µg/m^3 (Sullivan, 2001). Formaldehyde levels measured on the summit of Whiteface Mountain in Wilmington, New York, ranged from 0.98 to 3.2 µg/m^3 (Schulam, et al., 1985) which are approximately 8 to 27 times higher than the modeled concentrations at Brookman Corners. Formaldehyde is present in air primarily from by-products of combustion of fossil fuels (e.g., coal, oil, wood, and natural gas) with cars being the largest contributor (ATSDR, 1999).

6.1 Time-Weighted NAAQS

Commenters objected to the reporting of concentration of constituents in tons per year because annual averages minimize periods of peak concentrations and are therefore not appropriate for assessing health risk. The NAAQS were developed to protect the public and sensitive subgroups with an adequate margin of safety and are provided in terms of air concentration (µg/m^3). The NAAQS include standards for long-term (annual) and short-term (1-hour, 3-hour, 8-hour and 24-hour) periods.

Table 15 in section B.9.1 of the EA presents NAAQS compliance results for Horseheads, Sheds, and Brookman Corners Compressor Stations. For each compressor station, pollutant, and averaging period, the sum of the maximum predicted concentration from facility operation plus the background concentration is less than the applicable NAAQS. Therefore, impacts on air quality from operation of the Project facilities would not cause violations of a NAAQS. DTI would also be required to meet all applicable requirements specified in the modified Air State Facility and Air Title V issued by the NYSDEC.

Additionally, as previously discussed above in chapters 4 and 5, the risk assessment included an evaluation of highest predicted 1-hour air concentrations from the compressor stations, both for emissions from normal operations and a full-station ESD blowdown. None of the modeled concentrations of the constituents of concern exceeded a level of health concern using health-conservative assumptions.

6.2 Combustion Source Comparison

In order to put the level of potential emissions from the compressor stations into perspective, we compared the proposed emissions to common "everyday" combustion sources such as home heating with fuel oil or wood and with car and light truck vehicle emissions. Table 16 presents a comparison of emissions on a pound per day (lb/day) basis.

Table 16
Comparison of Maximum Daily Compressor Station Emissions with Rural Combustion Emissions

	Compressor Stations Combustion Emissions (lb/day)			"Everyday" Sources of Combustion Emissions (lb/day)			
Pollutant	**Sheds**	**Horseheads**	**Brookman Corners**	**Home Oil Heating a/**	**Wood Stove b/**	**Passenger Car c/**	**Light Duty Truck or SUV d/**
NO_x	133.7	133.7	363	0.06	0.11	0.05	0.07
CO	36.2	31.8	183	0.012	8.3	0.68	0.86
$PM_{10/2.5}$	35	35	72	0.001	1.1	0.0006	0.0007
SO_2	3.8	3.8	6	0.0008	0.01	ND	ND
VOCs	15.9	15.9	133	0.003	1.9	0.07	0.09
Formaldehyde	0.55	0.55	12	ND	0.07 **e**/	ND	ND

Comparison Scenarios:
a/ Based on average use of a home in the Northeast, assuming AP-42 emission estimates (EPA, 2010), 645.4 gallons heating oil/year average consumption (Andrews and Perl, 2014) and October 1 – March 31 heating season (NYSERDA, 2015).
b/ Based on emissions from a conventional wood stove, assuming AP-42 emission estimates (EPA, 1996), burning 4 cords of firewood/year (Hetzler 2015), and October 1 – March 31 heating season (NYSERDA, 2015).
c/ Average passenger car mileage of 12,000 miles/year, 24.1 mpg (EPA, 2008).
d/ Average light truck/SUV mileage of 15,000 miles/year, 17.3 mpg (EPA, 2008)
e/ From Li, V.S. 2007. Conventional Woodstove Emission Factor Study. On-line at: http://www.epa.gov/ttnchie1/conference/ei16/session5/victor.pdf.

Notes:
CH_4 = Methane
ND = No Data
HFC = Hydrofluorocarbons/ perfluorocarbons
mpg = miles per gallon
N_2O = Nitrous Oxide
NYSERDA = New York State Energy Research and Development Authority
SUV = Sport Utility Vehicle
lb/day = pound per day. Calculated as follows:
For Station emissions – tons per year x 2000 lb/ton / 365 days/yr
For Home Oil Heating – lb/1000 gallons x 645.4 gallons/yr / 183 days/yr (heating season)
For Wood Stove – lb/ton of wood x 4 cords/yr x 3291 lb/cord x ton/2000 lb / 183 days/yr (heating season)
Car/Truck Emissions – lb/yr / 365 d/yr

Table 17 presents the same comparison in terms of number of units (e.g., number of homes burning oil or wood, number of cars or light trucks/SUVs) that would be needed to achieve the same level of emissions as the compressor station.

Table 17
Comparable Emissions to Rural Combustion Sources

Pollutant	Number of Equivalent "Everyday" Sources of Combustion Emissions			
	Home Oil Heating a/	**Wood Stove** b/	**Passenger Car** c/	**Light Duty Truck or SUV** d/
NO_x				
Sheds	2,228	1,215	2,674	1,910
Horseheads	2,228	1,215	2,674	1,910
Brookman Corners	6,050	3,300	7,260	5,186
CO				
Sheds	3,017	4	53	42
Horseheads	2,650	4	47	37
Brookman Corners	15,250	22	269	213
$PM_{10/2.5}$				
Sheds	35,000	32	58,333	50,000
Horseheads	35,000	32	58,333	50,000
Brookman Corners	72,000	65	120,000	102,857
SO_2				
Sheds	4,750	380	ND	ND
Horseheads	4,750	380		
Brookman Corners	7,500	600		
VOCs				
Sheds	5,300	8	227	177
Horseheads	5,300	8	227	177
Brookman Corners	44,333	70	1,900	1,478
Formaldehyde				
Sheds	ND	8	ND	ND
Horseheads		8		
Brookman Corners		171		

a/ Based on average use of a home in the Northeast, assuming AP-42 emission estimates (EPA, 2010), 645.4 gallons heating oil/yr average consumption (Andrews and Perl, 2014) and October 1 – March 31 heating season (NYSERDA, 2015).
b/ Based on emissions from a conventional wood stove, assuming AP-42 emission estimates (EPA, 1996), burning 4 cords of firewood/yr (Hetzler, 2015), and October 1 – March 31 heating season (NYSERDA, 2015).
c/ Average passenger car mileage of 12,000 miles/year, 24.1 mpg (EPA,2008)
d/ Average light truck/SUV mileage of 15,000 miles/year, 17.3 mpg (EPA, 2008)

Notes:
ND = No Data

A few examples from table 17 are as follows:

- The potential level of particulate matter emissions from the Brookman Corners Station would be equivalent to the emissions from 72,000 houses burning oil for heating or 65 houses burning wood in a conventional wood stove;
- The potential level of Carbon Monoxide (CO) emissions from the Brookman Corners Station would be equivalent to the emissions from 15,250 houses burning oil for heating or 22 houses burning wood in a conventional wood stove, or from the emissions of 269 cars or 213 light truck/Sport Utility Vehicles (SUVs);
- The potential level of VOC emissions from the Sheds and Horseheads Compressor Stations are equivalent to the emissions from 5,300 homes burning oil for heating or 8 homes burning wood in a conventional wood stove, or from 227 cars or 177 light trucks/SUVs; and

- The potential level of formaldehyde emissions from the Sheds and Horseheads Compressor Stations are equivalent to the emissions of 8 homes burning wood in a conventional wood stove, while for Brookman Corners, the potential formaldehyde emissions are equivalent to 171 homes burning wood in a conventional wood stove.

Although the potential emissions from the compressor stations would be, in some cases, considerably higher than the common "everyday" combustion sources, there is a potential, based upon the number of units needed, where CO (wood stoves, passenger cars and light duty truck/SUV), particulate matter (wood stoves), SO_2 (wood stoves), VOCs (wood stoves, passenger cars and light duty truck/SUV), and formaldehyde (wood stoves) from these everyday sources are comparable and could potentially exceed those of the compressor stations.

7.0 OTHER CONCERNS

7.1 Unconventional vs. Conventional Natural Gas

Some commenters expressed concern that the natural gas transmitted through the pipeline is "fracked gas." Once out of the ground conventional and unconventional natural gas are subject to the same processing, transport and end-use, as well as have indistinguishable atmospheric impacts after production (Moore et al., 2014).

7.2 Radon

We received several comments concerning the presence of radon and or radiation present in Pennsylvania-sourced Marcellus shale. The downstream use of natural gas in the market areas, including the effects of burning natural gas and exposure to radon in homes, is beyond the scope of this health assessment. Although the impacts of transportation of natural gas to downstream users are outside the scope of the health assessment and beyond our jurisdiction, we have previously provided a general background and a review of the literature on radon in natural gas.[4]

Radon can be entrained in fossil fuels including natural gas. Because radon is not destroyed by combustion, burning natural gas containing radon can increase the level of radon within a home (ATSDR, 2012). Almost all risk from radon comes from breathing air containing radon and its decay products (EPA, 2014c). Radon levels in outdoor and indoor air can vary widely. Outdoor air radon levels range from less than 0.1 to about 30 picocuries per liter (pCi/L). The EPA identifies the average outdoor radon levels at about 0.4 pCi/L. Radon in indoor air ranges from less than 1 to about 3,000 pCi/L. The EPA identifies that the average indoor radon level is 1.3 pCi/L and recommends that indoor levels be less than 2 to 4 pCi/L. In 1988, the U.S. Congress passed the Indoor Radon Abatement Act, which established the long-term goal that indoor air radon levels be equal or better than outdoor air radon levels.

[4] New Jersey-New York Expansion Project final Environmental Impact Statement (Docket CP11-56) issued March 2012, Rockaway Delivery Lateral and Northeast Connector Projects final Environmental Impact Statement (Dockets CP13-36 and CP13-132) issued February 2014, and the Algonquin Incremental Market Project final Environmental Impact Statement (Docket CP14-96) issued January 2015.

In addition to the literature review and studies in the above dockets, the Pennsylvania Department of Environmental Protection (PADEP) published its "Technologically Enhanced Naturally Occurring Radioactive Materials (TENORM) Study Report in January 2015. The study was initiated in 2013 to collect data relating to TENORM associated with oil and gas operations in Pennsylvania. The PADEP measured radon concentrations in natural gas at the well head in Marcellus Shale (3 pCi/L – 148 pCi/L), Oriskany Sandstone (19.9 pCi/L), Upper Devonian Shale (18.3 pCi/L – 92.2 pCi/L) and in the Utica formation (5.7 pCi/L) (PADEP 2015). PADEP also measured radon in natural gas entering and exiting a processing plant located in Washington County. Concentrations of radon measured in natural gas entering the processing plant were 67.5 and 71.1 pCi/L, while concentrations of radon measured in natural gas at the processing plant outflow were 9.3 and 8.6 pCi/L (PADEP, 2015).

Using the Marcellus Shale data (median value of 43.6 pCi/L, maximum value of 148 pCi/L), PADEP estimated the incremental increase of radon in a typical home that used natural gas for purposes such as cooking and heating. To be conservative, it was assumed that there was no decay during gas processing and transit. Based on the radon and natural gas data collected as part of the study and the conservative assumptions made, the incremental radon increase in a home using natural gas appliances is estimated to be very small (0.04 pCi/L for the median value and 0.13 pCi/L for the maximum value) and would not be detectable by commercially available radon testing devices. Therefore, there is little potential for additional radon exposure to the public due to the use of natural gas extracted from these geologic formations (PADEP, 2015).

We note that several factors that would further reduce indoor exposure to radon from natural gas as compared to PADEP's conservative model. Radon's half-life, defined as the time it takes for the element to decay to half its initial concentration, is relatively short (3.8 days). The time needed to gather, process, store, and deliver natural gas allows a portion of the entrained radon to decay, which decreases the amount of radon in the gas before it is used in a residence. Additionally, radon concentrations would be reduced when a natural gas stream undergoes upstream processing to remove liquefied petroleum gas. Processing can remove an estimated 30 to 75 percent of the radon from natural gas (Johnson et al. 1973), as demonstrated by PADEP's measurements at the Washington County processing plant. Other research suggests that the cumulative decay of radon from wellhead to burner tip is around 60 percent (Gogolak, 1980). Finally, indoor radon exposure associated with the residential combustion of natural gas may be lower now due to the improved ventilation and increased energy efficiency of modern boilers, furnaces, and hot water heaters, as well as new building codes requiring venting of gas-fired stoves and ovens.

The levels of radon associated with the burning of natural gas at compressor stations would be lower than at the wellhead. As is the case for the burning of natural gas in the home, the levels of radon would be reduced due to upstream processing, natural decay, and efficiency of the turbines. Any radon in the compressor station emissions would be vented to the atmosphere and quickly diluted by mixing with the surrounding air. While the FERC has no regulatory authority to set, monitor, or respond to indoor radon levels, many local, state, and federal entities (e.g., the EPA) establish and enforce radon exposure standards for indoor air. Based on the analysis above, we find that the risk of exposure to radon in natural gas is not significant.

We also received a comment concerning the potential buildup of decay products within the pipeline and the risk of releasing these products to the environment either during pipeline maintenance or the removal of existing pipe. DTI would clean the pipeline to be removed prior to its being reused for another purpose. DTI also conducts annual inspections and regular cleaning of its operational pipelines. Any liquids or solids removed during these cleanings would be collected and treated as hazardous material that would be disposed of at a licensed facility in accordance with federal, state, and local regulations. These measures would minimize the risk that any radioactive solids would be released to the environment.

7.3 Food Supplies

Several commenters expressed a concern that the deposition of emissions from the compressor stations would impact crops, livestock, waterbodies and fish. With the exception of the PAH compounds (acenaphthene, acenaphthylene, benzo(b)fluoranthene, benzo(g,h,i)perylene, chrysene, fluorene, fluoranthene, naphthalene, 2-methylnaphthalene, phenanthrene and pyrene), none of the emitted HAPs are considered to be Persistent Bioaccumulative Toxic compounds (EPA, 2015d). The PAHs do tend to persist in the environment and potentially can be taken up by plants from impacted soils as well as bioaccumulate in fish; however, many plants and animals are able to metabolize and eliminate these compounds (ATSDR, 1995). Additionally, as shown in tables 6, 8, and 10, the emitted air concentrations of these compounds over an extended period are extremely low and therefore are considered to be an insignificant source of PAHs in the environment. PAHs are commonly emitted as products of inefficient combustion and uncontrolled emissions (Freeman and Cattell, 1990; NRC, 1983; Tan et al., 1992 as cited in ATSDR, 1995), and the residential burning of wood is the largest source of atmospheric PAHs (Ramdahl et al., 1982). The most important mobile source of PAHs are vehicular exhaust from gasoline and diesel-powered engines (Back et al., 1991; Johnson, 1988; Yang et al., 1991).

8.0 CONCLUSIONS

We conclude that the modeled HAPs emissions from normal operations and blowdown events from the proposed Horseheads and Sheds Compressor Stations as well as the upgraded Brookman Corners Station are below a level of health concern. Further, our analysis uses consistently conservative assumptions such as individuals exposed to maximum concentrations from full-capacity facility operation for 24 hours per day, 350 days per year. We also evaluated short-term maximum concentrations from conservative meteorological conditions. In response to the concerns about VOC emissions, the analysis demonstrates that each compressor station's VOC emission rate would be equivalent to 8 to 70 times the rate of VOCs emitted by a single wood stove. Finally, full station blowdowns would result in the potential to detect natural gas odors near the property lines; however, these impacts would occur for a short duration every five years and would not pose any discomfort, irritation, or mild health effects. We conclude there would be no significant impact on health in the Project areas from inhalation of emissions associated with the proposed / modified compressor stations.

8.1 Normal Operations

We concluded that the modeled emissions from normal operations would be below a level of health concern, using consistently conservative assumptions in our analyses. Potential total excess lifetime cancer risk and non-cancer hazard indices (measures of non-cancer risk for chemical mixtures) were calculated for a theoretical “reasonably maximally exposed” (RME) adult and child as a result of chronic (long-term) exposures to the highest predicted five-year average HAP concentrations emitted during normal operations (i.e., exhaust emissions from natural gas combustion and emissions resulting from releases of natural gas from fugitive emissions and venting). Total excess lifetime cancer risks were below 1 in a million and non-cancer hazard indices were below the benchmark level of 1.0, below which the EPA and other State or Health Agencies have determined a sensitive individual can be exposed without a risk for non-cancer health effect.

The results of the evaluation for all three stations indicated that acute exposures to the highest predicted 1-hour emissions during normal operations would be well below these benchmark criteria. The potential for acute (short-term) health effects due to exposures to the highest predicted 1-hour HAP concentrations emitted during normal operations was evaluated to account for periods of high exposures. Air concentrations were evaluated against acute inhalation exposure criteria (AIEC) which are intended to protect the general public, including sensitive subpopulations, against a variety of toxic endpoints. The AIEC that were used also protect against discomfort, mild health effects, and/or objectionable odor.

8.2 Blowdown Events

While the predicted concentrations would be below a level of health concern, we found some potential for odors from concentrations of pentane and hexane, native to the natural gas itself, to be detected during full station blowdown events near the station property line. This analysis focused on the full station blowdowns which are scheduled to occur every five years and/or during true emergencies; smaller venting activities occur as part of regular maintenance and were taken into account in the normal operations model. Air concentrations were evaluated against the same AIEC criteria described above. The results of the evaluation for all three stations indicated that acute exposures to the highest predicted 1-hour vented natural gas emissions during a full station blowdown would be below a level of health concern.

While the natural gas would not be purposefully odorized, we determined that there may be some potential for odors to be detected during the station blowdown events especially near the station property lines. The predicted 1-hour concentrations of pentane and hexane exceed their respective odor threshold by approximately 2 to 9 times for pentane and 2 to 4 times for hexane. The concentrations of these constituents decrease by 20 percent (Brookman Corners Compressor Station) to 60 percent (Horseheads Compressor Station) at 200 feet from the property line of each respective station. We note that the distances from the nearest residences to the predicted points of maximum 1-hour concentrations range from 1,050 feet (Brookman Corners Compressor Station) to 1,375 feet (Sheds Compressor Station).

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